THE COMMUNICATOR
SURREY AMATEUR RADIO CLUB

Volume II **September 2009** **Issue XXXVII**

VE7SAR **VE7RSC**

PRESIDENT– Heinz Buhrig VA7AQ
VICE PRESIDENT - Egon Frank VA7EGO
SECRETARY—Gordon Kirk VE7GRK
TREASURER - Scott Hawrelak VE7CNR
WEB SITE - http://www3.telus.net/ve7sar/
WEB MASTER - Hiu Yee VE7XYG
COMMUNICATOR EDITOR—Fred Orsetti VE7IO
BOARD OF DIRECTORS:
John Schouten - VE7TI
Anton James VE7SSD
Fred Orsetti - VE7IO
John Brodie VA7XB

SARC
Surrey Amateur Radio Club

ALWAYS MONITOR 147.36+ (110.9) OR 443.775+ (110.9 in and out) IRLP 1463

CLUB NET @ 8:00 P.M. Tuesday 147.36+ (110.9)
CLUB MAILING ADDRESS : 239 -7156 121 St. Surrey, B.C. V3W 0J6

The next meeting of the Surrey Amateur Radio Club will be held at 7:30pm on Wednesday October 7th 2009 at the Provincial Regional Emergency Operations Center (PREOC) located at 14275 96th Avenue Surrey V3 T 4M5 - Enter off 96th Talk in on 147.36+ (110.9) 443.775+ (110.9)

Minutes for Sep 9, 2009 SAR Club Meeting

1. The meeting was called to order at 7:35 pm September 9, 2009 chaired by President Heinz VA7AQ. 17 members were in attendance at the Surrey PREOC building.

2. Executive and Directors were introduced. Heinz VA7AQ President, Egon VA7EGO Vice-President, Gordon VE7GRK Secretary, and Scott VE7CNR Treasurer. Directors present John VA7XB, John VE7TI, Bill VE7XS, Fred VE7IO. Anton VE7SSD sent regrets, as he was unable to attend.

3. Call to add to the agenda, no further items to add.

4. Treasurer's update. $1167.64 in the HSBC account. No changes to the ING GIC account, Scott still needs access to get up to date info. Scott has the required forms to go to the bank to change the account over to allow him access.

5. Discussion of standing committee's and those leading them.

a). Health and Welfare. Heinz will ask

Anton if he will continue in this role.
b). Social Committee Alan VA7BIT volunteered.
c). Field Day 2010. Heinz will ask Anton if he will continue in this role.
d). Flea Market. Wayne VE7HM had offered to continue with this. He has tentatively booked Sullivan Hall. Some discussion around the date occurred as other groups set their dates as well as the Olympic dates as well.
e). Antenna Support. Fred VE7MPI will continue in this role. Some discussion about replacing the analyzer happened. A suggestion to have a club night about analyzers, and the different models available happened.
f). Contesting. Fred VE7IO will help in this area.
g). DXpedition. Heinz will lead this and look into booking the Deas Island site for an upcoming contest 2009 W/VE QSO Party October 17+18th.
h). Quartermaster (Club Inventory storage) Heinz will ask Anton if he will continue in this role.
i). Membership List. Don VA7GL offered to continue.
j). Net Control Manager. John VA7XB will coordinate the schedule. Several club members offered to assist. The final schedule will be posted on the website.
k). WebMaster. Hui VE7XYG will continue with this.
l). Volunteer Examiners. John Brodie VA7XB, John Schouten and Gary VE7AS.

6. Bill Gipps gave an update. RAC provides club liability insurance. RAC is working on a new web look and services.
Bill also spoke about an opportunity to help with a dog sled race in January. Check out his website www.isv.com for further details.
Work is still continuing with a group to provide special event stations during the upcoming 2010 winter Olympics. 4 letter call signs will be available and with a sign up procedure you may be able to operate from your home at a designated time, band and mode.

7. Club Membership form will be redone by Egon related to privacy statement being added.

8. Field Day Report. Fred and Pat worked on the scoring submission. Those attending had a great time. More antennas should be looked at next year. GOTA was a success. A review of the Power Distribution is needed and John VE7TI, Fred VE7IO, Egon VA7EGO and Kelvin VA7KPH volunteered.
John VA7XB has designed and built a generator cover for the big yellow trailer. He still has to install it.

9. Fred VE7IO made a presentation for an upcoming Parkinson's Walk in Bear Creek Park Sept 27. He asked for support, he will be walking in the event.

10. John VE7TI presented a small project called the Tiger Tail. It is a counterpoise antenna for handhelds. This is a small kit the club will build at the next meeting. A motion was made and passed allowing John to purchase materials for up to 40 kits and the club will reimburse him.

11. A CW class was discussed and we will move forward with this.

12. A reminder for the upcoming Delta Flea Market on OCT 4th was made. There is a club table available.

13. A reminder of the upcoming SEPAR 1st annual general meeting on Sept 26th at South Surrey Rec Centre (14610 20th Ave) for all those interested.

Next Meeting Oct 7th at the same location, the Surrey PREOC.

Interesting stats for B.C.

Contributor Gary Skett VE7AS

When you look at these numbers, especially Surrey, what [small] percentage do we have in SARC? In each city, probability indicates only 20% of those Hams with call signs are actually active on the air...

Call Signs Per City

September 24, 2009

Total Call Signs On File for B.C.
13,787

VA7 Call signs
3665
26.58%
VE7 Callsigns
9,673
70.16%
Others (VY1 to VE9)
449
3.26%

Vancouver
1296
9.40%
Victoria
1187
8.61%
Surrey
780
5.66%
Burnaby
518
3.76%
Richmond
491
3.56%
Kelowna
434
3.15%
North Vancouver
426
3.09%
Coquitlam
356
2.58%
Langley
323
2.34%
Delta
300
2.18%
Kamloops
298
2.16%
Prince George
281
2.04%
Abbotsford
280
2.03%
Vernon
278
2.02%
Nanaimo
263
1.91%
Maple Ridge
230
1.67%
No Address on File
209
1.52%
Port Coquitlam
206
1.49%
Penticton
193
1.40%
West Vancouver
175
1.27%
Chilliwack
161
1.17%
New Westminster
154
1.12%
Mission
127
0.92%
Salt Spring Island
117
0.85%
Campbell River
111
0.81%
White Rock
63
0.46%
Aldergrove
55
0.40%
Brentwood Bay
30
0.22%
Bowen Island
20
0.15%

John Brodie has for sale:

Manual?
Yaesu
FT-736R
VHF/UHF all mode Transceiver
yes
hand mic
144, 440, 1.2 GHz modules

Astron
RS-35M
35 amp power supply

Unknown make
HP-312A
3 amp power supply

Heathkit
HD-1250
solid state grid dip meter in case, with coils
yes

Heathkit
IC-5282
audio generator
yes

Bird
43 thruline directional wattmeter
yes
N-type
10K, 50K, 100C, 100D, 100H,
c/w with 6 slugs

2500H slugs included
Heil HM-5 desk mic (type?)

Micronta
Power/SWR meter

Heathkit IO-17 Oscilloscope

Heil
EQ200P Microphone equalizer
yes

Comet CFX-4310 triplexer

Comet CFX-4310 triplexer

Diamond MX-3000 triplexer

Diamond MX-3000 triplexer
cables cut off

Kuhne Low Noise Oscar 40 converter

SSB Electronic UEK-2000 Sat Down Converter

SSB ElectronicS-Band Beacon 2400 MHz

Palomar R-X Noise Bridge
yes

RF-Power Protector with DC feed-thru

Down East Microwave 2370 PA
2.3 GHz Microwave power amplifier

TE Systems 4412G 440 MHz RF Power Amplifier (160 watts)
yes

TE Systems 1412G 144 MHz RF Power Amplifier (100 watts)
yes

misc RF connectors 14
N-type

11 UHF type

Parts Drawer including parts

Assorted wire

Ladder line

Assorted coax

Rotator cable

110 v fan

110 v coax relay

Books
1989 ARRL handbook (hardcover)
1988 ARRL Antenna Book
1989 Microwave Handbook (G3PFR)

1988 HF Antennas (G6XN)

1989 Practical Wire Antennas (G3BDQ)

1991 HF Antenna Collection (G4LQI)

1989 VHF UHF Manual (G6JP)

Beam Antenna Handbook (W6SAI) (date unknown)

Quad Antennas (W6SAI 3A2AF) (date unknown)

1971 101 Ways to Use Your Oscilloscope

1987 Celestial Navigation (Jeff Toghill)

1997 The Starfinder Book (David Burch)

1986 Celestial for the Cruising Navigator (Merle Turner)

1999 The Complete On-Board Celestial Navigator (George Bennett)

Larger Items Still at Bishops

20' tower

rotator

rotator

dish

loop yagi

50 ft 1" Heliax

Misc. cable

BCYL - CLARA 2007 Conference Project

The 'TigerTail' LED Counterpoise

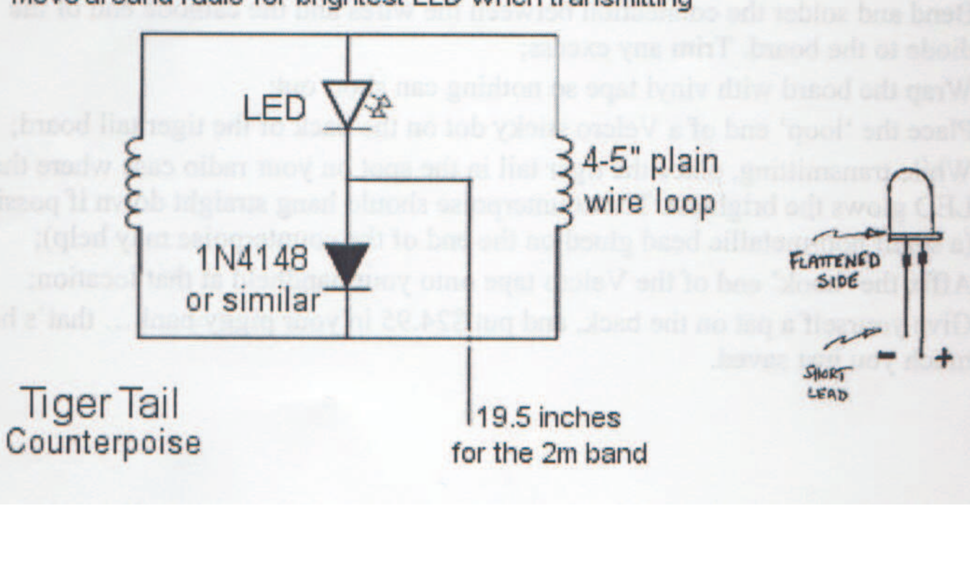
John Schouten, VE7TI

The project we are building is very practical for the hand-held radio user. Your hand-held radio probably has a flexible antenna commonly known as a 'rubber duckie'. This antenna is practical because it flexes, and it is short – typically wound in a spiral to reduce the length, but this convenience is far from efficient, often with a Standing Wave Ratio (SWR) exceeding 2:1. As a result, your radio antenna does not radiate as efficiently as it should. The reflected power creates extra heat in the radio and wastes your battery.

Why you ask? Well, the minimum antenna at 2-metres is typically a quarter-wave (approx 19.5 inches). A quarter wave antenna is common on police cars, taxis and perhaps your 2-metre mobile rig because it can be mounted on the centre of the roof. The metal car body provides a good ground-plane which makes up for the 'missing' half of the dipole antenna. In the case of your hand-held with the rubber-duckie this ground-plane is missing. The TigerTail adds a quarter-wave element to the hand-held. This gives you a half-wave vertical and, unlike a quarter-wave antenna, a half-wave antenna doesn't need a ground-plane to work efficiently. What we are doing with this project is adding the missing half of the quarter-wave antenna. This missing half is known as a counterpoise. You will notice a difference when working a weak station or distant repeater.

How does the circuit work? It is a very basic detector circuit. The wire loops pick up the RF field from the transceiver. The diodes (remember the LED is a diode too) rectify the RF into a DC current which lights the LED. When the LED glows brightest it is an indication that the maximum current is being induced into the circuit, and the maximum counterpoise benefit is realized.

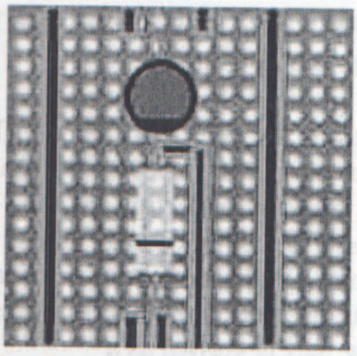
The LED is unnecessary for efficiency. A single 19.5 inch wire attached to the base of the rubber duckie will have a similar beneficial effect. What the LED does add is a visual means to find the 'sweet' spot on your hand-held. This will be the place on your radio model where the counterpoise will be the most efficient.



Parts List

1-inch square printed circuit board	1 LED
20-inch length of stranded hook-up wire	1 1N4148 diode (or equivalent)
2x 8-inch lengths of stranded hook-up wire	Vinyl tape and a Velcro sticky dot

Parts Placement and Assembly



1. Place the LED flat, in the centre on top of the board with the shortest lead (cathode) toward the middle. Note the LED also has a flat side, which is also the cathode side;
2. Bend the leads of the glass diode and place it flat on the board with the unmarked lead (anode) in the same hole as the short LED lead. Insert the banded end (cathode) towards the outside and 2 holes away from the anode;
3. Insert one stripped end of the 20-inch antenna wire in place in a hole adjacent to the centre of the two diodes and bend then together so they touch;
4. Solder the common connection between these three components to the board, without overheating them;
5. Loop the antenna wire through the enlarged hole beside these components to act as a strain relief. Trim the antenna wire to 19.5 inches;
6. Twist a ¼-inch stripped end of each 9-inch RF loop wire together and thread both into holes next to the anode end of the LED;
7. Bend and solder these wires in place together with the loose wire (anode) of the LED. Trim any excess leads, keeping everything as flat and compact as possible;
8. Tightly wind 3½ turns of the 8-inch wires around the board on either side of the diodes and, after trimming any excess wire, thread the stripped loose ends into holes on the board beside the cathode end of the glass diode;
9. Bend and solder the connection between the wires and the cathode end of the diode to the board. Trim any excess;
10. Wrap the board with vinyl tape so nothing can short out;
11. Place the 'loop' end of a Velcro sticky dot on the back of the tiger tail board;
12. While transmitting, place the tiger tail in the spot on your radio case where the LED glows the brightest. The counterpoise should hang straight down if possible (a small non-metallic bead glued on the end of the counterpoise may help);
13. Affix the 'hook' end of the Velcro tape onto your handheld at that location;
14. Give yourself a pat on the back, and put $24.95 in your piggy bank… that's how much you just saved.

SCIENTIFIC AMERICAN

A WEEKLY JOURNAL OF PRACTICAL INFORMATION, ART, SCIENCE, MECHANICS, CHEMISTRY AND MANUFACTURES.

[Entered at the Post Office of New York, N. Y., as Second Class Matter.]

Vol. XLVII.—No. 7. [NEW SERIES.] NEW YORK, AUGUST 12, 1882. [$3.20 per Annum. [POSTAGE PREPAID.]

Requisites for a Good Operator.

A correspondent writes that he is able to transmit forty-two words a minute, by the watch, for a considerable length of time, and to receive, without difficulty, the writing of a private line with forty offices, some of them occupied by Western Union operators, and he desires to know whether this degree of skill entitles him to be rated as a good operator. Inquiries of this kind are often received, implying that ability to transmit and receive a specified number of words per minute constitutes a standard by which a good or a "first-class" operator may be distinguished—an error very common to novices, and very mischievous. Speed, when combined with other qualifications, is certainly a very desirable accomplishment, but it is not the first requisite of telegraphic skill. Some of the men who have ranked highest in the profession have not been remarkable for speed. It is the old story of the tortoise and the hare over again; it is the steady gait and sound judgment that tell. If the correspondent can transmit forty-two words a minute in good, ringing Morse, and can transcribe from a line at the same rate, making every letter unmistakably legible (not necessarily ornate); if he can quickly adjust his instrument to every variation in the circuit, particularly in bad weather, or on a faulty line; if in sending he exercises judgment, and gauges his writing to the ability of the receiver; if he has that peculiar telegraphic sense which enables him to instantly detect an error, even in a cipher message; if he never "breaks" except when in doubt as to the correctness of a word, and then always breaks; if his habits are irreproachable; if he has the good sense never to allow his temper to be ruffled by anything that occurs on the line; if he can do and be and suffer all this for nine hours a day, without leaving his chair, then he may justly claim to be a good operator. If, in addition to these accomplishments, he can transmit forty-two words a minute with one hand, while "timing" with the other the messages he has sent, and can eat his frugal luncheon without suspending either of the other operations, he may be regarded as a first-class operator, and will probably have no difficulty in obtaining a position at from $70 to $80 per month. All that is then necessary is for him to become thoroughly conversant with the properties of electricity, and the applications thereof, and he is reasonably certain (if he lives) to reach the top of the profession, the length of time required depending to a great extent upon the maneuvers of a certain gentleman in New York, Mr. Jay Gould.—*The Operator.*

Antenna Myths

With Gary W. Skett, VE7AS

What a fantastic summer of experimentation – antenna experimentation. So many newbie Hams have made a number of antennas for home, field day (portable) and mobile use. Kinda makes one all warm and fuzzy inside to see the revival of DIY antennas. So I thought it would be a good idea to go over some concepts, mention a few new things and discuss a few points of interest I discovered over the last few months. I have been busy rebuilding/refurbishing rotors, which I'll cover in the next issue, and working on getting my antenna system set for winter... More on that later as well... Egon, VE7EGO and members of the LARA club have also been working on mobile NVIS and satellite systems, and Ron VA7AUZ built an eggbeater for VHF ISS work [as well as terrestrial contacts] this past summer. I'm hoping to include some of their projects here in the coming months.

But back to topic; there is so much misinformation floating on the Internet about antennas in general, and mobile antennas specifically, it's not surprising many newcomers are confused. Although a good portion of the information presented here is from other articles within published texts and magazines and some [I admit] from the World Wide Web, it's best to set them out here in an effort to correct some of the more popular myths. While some of them can be applied to base station antennas as well, the thrust here is aimed at HF mobile antennas. So go get a large coffee, find a comfy chair and "lay on, Macduff..."

Terms used here are the same as those explained in the Antenna Efficiency article at the end of this topic, so some of you might want to read that first. Readers should also acquaint themselves with the different types of grounds, and ground planes and find a glossary of terms for terms not defined herein.

Ground Loss Myths

A vehicle is not a ground plane for an HF antenna. Rather, it is a capacitor between the antenna, and the surface under the vehicle in question. That surface, whatever it is, forms the actual ground plane, albeit rather lossy. Depending on the reference, the stated ground loss for an average vehicle varies between 2 and 10 ohms (10 through 80 metres). The real world figures are closer to 5 to 20 ohms. In other words, it's equivalent to a capacitor with a value of between .004 µF to .002 µF.

One of the reasons ground plane-less verticals (no radials, perhaps just a pipe or ground rod) do not perform well, is because the current returned to the source is forced to travel though lossy (darn word processor keeps wanting to change that word to "flossy") ground. A similar situation exists in a mobile installation. That is to say, some of the antenna current returning to the source flows through the surface under the vehicle, rather than through the vehicle itself. This fact increases ground losses.

One of the base-station workarounds, is to elevate the antenna away from the poor conducting ground surface, and use an artificial ground plane; radials in other words. However, we don't have that luxury in a mobile installation. There is one thing we can do, and that's raise the antenna as high as possible on the

vehicle, consistent with local height restrictions (legal, trees, wires, etc.). Doing so reduces the coupling between the antenna and the surface under the vehicle, which increases the current flow through the body of the vehicle, and reduces the overall ground losses. It should be noted that a proper mobile installation will always have more ground loss than a proper base station installation.

The effect can be shown graphically by using antenna modeling software like EZNEC. However, modeling programs often don't calculate ground losses accurately, even in ideal situations. When they're used to model vehicle installations, ground loss calculations are even less exact, due in part to the complexity of accurately modeling a vehicle's superstructure. Thus, the often-quoted data relating to mobile HF antenna models is often contrary to empirical testing.

Incidentally, the number of modeling segments in EZNEC required to duplicate an average vehicle's real-world condition exceeds 200. A fact which requires the full-blown, commercial version, not the free downloadable version.

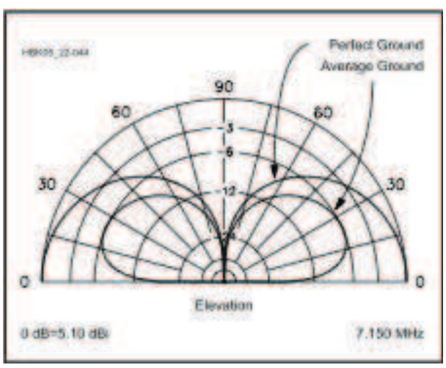
There's another important item with respect to ground losses which needs addressing, and that is consistency in ground conductivity. While the mean deviation over a large statistical area may be fairly narrow, over a small statistical area the mean deviation can be rather drastic. Adding insult, mobiles operate on paved surfaces for the most part, and road surfaces are even more inconsistent than soil surfaces.

Lastly, the mean deviation in soil conductivity changes as the moisture content, and surface temperature of the ground changes. In fact, the changes are often great enough, that you can measure the difference in input impedance between morning, and evening. This fact is yet another reason antenna shootouts are not definitive.

Here's one more important point to ponder. Most amateurs wouldn't think about installing a base-station dipole antenna with the elements parallel to one another, and spaced 6 to 8 inches apart. Yet, that is essentially what they're doing when they mount an HF mobile antenna on the back of a van or SUV utilizing a trailer hitch type mount.

Radiation Pattern Myths.

The angle of radiation from a horizontal antenna is rather dependant on the ground conductivity under the antenna. This fact is why height above true ground is so important to horizontal antennas. However, when it comes to verticals, height isn't so important, as long as the ground losses are low. There are a couple of ways to accomplish this with a base-station vertical. One is to lay out a bunch of radials (at least 25 or so) under the antenna, or raise the antenna off the ground, and use a lesser number of elevated radials. Rather than insert a book-length dissertation at this point to explain why this is so, I suggest you read Rudy Severns', N6LF, series of white papers on the subject. If you want the short course, read his PowerPoint® presentation.



To quote Rudy Severns, *Any practical ground system will not affect the radiation angle or far-field pattern*! In fact, a vertical without any radials will have virtually the same angle and pattern as one mounted over a perfect ground plane, albeit at a much reduced level (see chart at left). Rudy goes on to say, *the ground system around the antenna does nothing for the far-field pattern except to increase the power radiated for a given input power*. Any change in the angle of radiation, is due to the presents of common mode currents, and factors not associated with ground loss.

We can reduce the ground losses in a mobile installation by increasing the mounting height of the antenna, as noted above. Two things happen when you do. First, the resonant frequency increases, due in part to a reduction in the capacitive coupling between the antenna, and the surface under the vehicle. The ground losses decrease, as does the input impedance, basically for the same reason. The reduction in ground losses effectively increases the antenna's efficiency; a worthy endeavour! Incidentally, this is why good installations require antenna matching networks (antenna input impedance less than feed line impedance), and poor ones typically do not.

Another common myth is the level of distortion in the radiation pattern caused by the body of the vehicle. Yes, the pattern is distorted, but not nearly to the level most folks believe. Regardless of the aforementioned shortcomings of modeling software, they're fairly accurate in modeling the radiation pattern. In fact, they fairly mimic empirical testing. That is, if folks are willing to go through the necessary, 200+ machinations to describe the vehicle's superstructure to assure accuracy. If you do, you'll discover the differences are seldom more than about 3 dB. However, the difference may be somewhat greater when modeling antennas mounted low on the back of vans and SUVs. I might add, if the modeled (or real world) measurements exceeds 10 dB, then a higher, less lossy mounting location is in order.

Proponents often challenge the aforementioned findings, by driving around in circles as a test of the theory. They should remind themselves, those instantaneous changes in atmospheric propagation, and changes in ground conductivity, are far more telltale than the distortion caused by the body of the vehicle.

There is a related myth which needs to be dispelled. That is, ground conductivity in areas near the ocean account for increased propagation and signal strength, and even lower angles of radiation. The truth is, the effect is largely a result of a clear horizon unencumbered by structures, and flora. Again, localized ground losses have no measurable effect on the *radiation angle or* (the) *far-field pattern*!

The NVIS Myth

During WWII, the German army used wire beam antennas, wherein the reflector was laid on the ground, with a radiating element closely spaced above it. The resulting radiation pattern contained a lot of high-angle energy. The description used to designate the radiation was Near Vertical Incident Skywave, hence the NVIS moniker.

At about the same time, U.S. Army signal corpsmen noticed they could *sometimes* hear the German stations better when they bent over the whip antenna attached to their command sets. But it wasn't a result of producing an NVIS radiation pattern. Rather, it was a result of capacitive antenna loading which reduced the level of the incoming signal, and increased the S+N/N ratio making copy easier. The same effect can be demonstrated by turning down the RF gain.

After the hostilities were over, some hapless fellow combined these two, really unrelated, items creating the myth that bending over the whip of a mobile antenna produces an NVIS pattern. Of late, the internet has allowed this myth to propagate (excuse the pun) beyond all belief and reason.

The myth can be easily dispelled by modeling a vertical antenna with, and without, a bent-over whip. Be careful, however, as there will be changes in the input impedance, and resonant frequency. Proponents misconstrue these changes as support for the myth. Or, they site S meter readings, which are suspect at best.

The DX Myth

There are several inexpensive ways to measure an antenna's input impedance with a fair degree of accuracy, typically ±5%. If you have, and know how to use, antenna modeling software, you can get fairly close to an antenna's real-world efficiency by comparing the measured parameters against calculated ones. And, if you have the acreage, the right kind of test equipment, a fair knowledge of antenna theory, some cash liquidity, and a whole lot of time on your hands, you can even measure the signal strength at any given angle of radiation within a few percentage points. Alas, most amateurs don't have these attributes, so they resort to all manner of myth to describe their antenna installation.

Measuring the SWR is an easy task, and I suspect this is why neophytes often use SWR as a means of quantifying and qualifying their antennas. The truth is, a low SWR means nothing other than your transceiver will be happy. The same goes for bandwidth. Fact is, in an HF mobile scenario, wider bandwidth usually relates to lower efficiency.

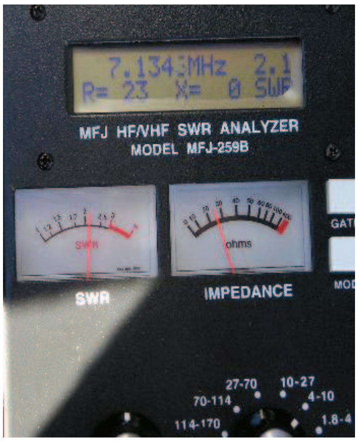
No doubt, the single, most often used reference (past the point of triteness) is the number of DX stations, said antenna installation garnered. How or why this practice got started is an unsolvable mystery. In reality, like SWR or bandwidth, it has no relationship to any theoretical, real, or imagined antenna parameter. If it relates to anything, it's ego. And as condescending as it may sound, most folks who use their DX contacts as a reference, typically have the poorest of installations.

The Efficiency Myth

High-frequency mobile antennas are not perfect performers, regardless of their owner's DX claims. For example, if you were to mount a 1/4 wave, 10 meter resonant antenna (8.2 feet long), made of solid silver rod, in the middle of the roof of an average vehicle, the efficiency would barely meet 90%. In the real world, it's more like 80%. In other words, 100 watts might go in, but only 80 watts is radiated. As the frequency is lowered, the efficiency drops, and rather drastically. Fact is, the average commercial-manufactured, HF mobile antenna is about 1% efficient. That's not a misprint; 100 watts in, only 1 watt out, and you only get that if you mount it correctly! Sure puts new meaning into *QRP operation*!

Short, stubby antennas are much worse, as are thin spirally wound ones. It is not uncommon for the efficiency level for these antennas to drop below .3% (that's point three percent!) on 80 metres, and well below this figure on 160 metres. Mount one of these antennas on a clip or clamp mount, and you can easily halve the figure; .15%.

Length matters, as does adequate coil Q, and mounting height. Do everything right, and 80 meter efficiency can exceed 6%. Don't kid yourself; this isn't as easy as it sounds. It takes length (>12 feet), a high Q coil (300+), no doubt a cap hat, and a high mounting location with lots of metal mass under it. One thing is for sure, it's difficult to explain [and justify] these requirements when the DX myth is used as a yardstick



The SWR vs. Resonance Myth

A very common belief is that the lowest SWR point is always the exact resonant point. This is a myth! For example, an unmatched, HF mobile antenna, of decent quality, will have an average input impedance of ≈25 ohms at resonance.

This represents an SWR of 2:1. This fact can be easily demonstrated by measuring the input impedance with an antenna analyzer (shown left).

By definition, an antenna's resonant point will be when the reactive component is equal to zero (X=Ø). At that point in our example, the R value will read 25 ohms, and the SWR readout will be 2:1. If we raise the analyzer's frequency slightly, the reactive component will increase (inductively) along with a slight increase in the radiation resistance, hence the SWR will decrease, perhaps to 1.4:1.

Depending on the transceiver in question, the resulting reactance may or may not cause any major problems, but it is still advisable to properly match your antenna. It should be noted, however, if your antenna doesn't require matching (input impedance ≈50 ohms), you need a better antenna and/or mounting scheme.

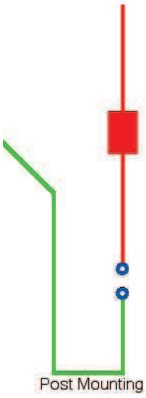
Last words...

For some, it's easier to believe the myth, than the antonym. If you're not one of them, and you want to have a better understanding of antennas, particularly HF mobile antennas, then the real key is to learn the theory behind them. The best way I know how to do that, is buy the [2010] ARRL Handbook – or 2009 when it goes on sale. Read it cover to cover 3 or 4 times, and enough will rub off that you'll know more than most licensed amateurs.

Antenna Efficiency

Important Points

One very important point needs to be made here. A vehicle is not a *ground plane*, but rather a capacitor between the antenna and the surface under the vehicle which acts as the ground plane. Since the surface in question is a poor conductor of RF, ground losses occur. The term *ground plane* in the following text is therefore a bit of a misnomer, but is used to differentiate it from DC and RF grounds.



Antenna efficiency is the *holy grail* of HF mobile operation, and here's why; Ground losses dominate the efficiency equation, and decreasing them by *just one ohm*, can make a significant difference in efficiency. This point should not be under estimated! Put another way, excessive ground losses can make an otherwise efficient antenna, into an also-ran. It should also be noted, that there is no way to directly measure ground loss.

Relating efficiency to a low SWR reading, the number of DX contacts made, or how well your antenna is grounded [RF or otherwise], is an inane practice.

The only effective way to measure an antenna's input impedance is to use an antenna analyzer.

M. Walter Maxwell, W2DU, author of *Another Look At Reflections*, made the following observation. "*With center-loaded mobile whips of equal size having no matching arrangement at the input terminals, best radiating efficiency is obtained on models having the lowest measured terminal resistance (highest resonant SWR, model for model). Models having lowest SWR are wasting power in the loading coil, because of either a low value of coil Q or excessive distributed coil capacitance, or both*."

What's hidden in the above observation is the amount of inherent (and induced) ground loss every mobile installation has. Remember, the highest efficiency, best quality, HF antenna money can buy, is no better than the ground plane it is mounted over. If you're unsure what a ground plane really is, read some articles on Ground Planes – from a text book, not necessarily from the Internet! This is also why Antenna Mounting methodology is so important in maximizing efficiency.

Mounting your antenna low, atop long stalks (as shown), and/or far removed from the ground plane (the vehicle in this case), is a prescription for poor performance. The worst part is, very few amateurs realize just how much difference in efficiency (performance) proper mounting can achieve. In fact, the difference can be as much as 25 dB, perhaps more. So before you decide to buy an amplifier, you should look at your antenna and its mounting methodology first.

The Factors

The input impedance of an HF mobile antenna is a complex mixture of resistive losses. The only good part is imaginary, and that's Radiation Resistance, commonly written as Rr. In simple terms, Rr is a function of the *effective* antenna length, not its physical length. In simple terms, the longer the antenna, the higher the Rr will be. It should be noted that the rate of change is by the square of the increase in length. That is to say, a 9 foot antenna will have twice the Rr of a 6 foot antenna. A 12 foot one will have four times the Rr of a 6 foot one. Rr may be as low as .2 ohms (80 metres), to upwards of 30 ohms (10 metres).

Coil loss (Rc), known as Q for quality, comes next. In simple terms, the Q of a loading coil is the ratio of the inductance, and the resistance of the coil measured at the resonant frequency. Under laboratory conditions, it is possible to obtain coil Qs in the 800 to 1,000 range. However, in the real world of mobile loading coils, it is difficult to obtain Qs over 300 when mounted in (on) an antenna. Even this takes good construction practices. Regardless of what hype you read or hear, most commercial antennas have Qs in the 100 to 200 range, and some antennas are as low as 20. Most spirally wound antennas fall into this latter category. Large (6 to 8 inches diameter) bug catcher coils are often advertised as having Qs in the 1,000 range. Fact is, they're closer to 300. These big coils also have low self-resonant points negating their use on the higher bands. While bigger is better in some cases, there is a diameter limit, and in mobile loading coils, that's about 4 or 5 inches depending on construction.

The biggest single factor [most of the time] is ground loss, written Rg, and is effectively in series with the input impedance. The average recognized figure varies from 10 to 2 ohms (80 through 10 metres), but may easily be double this figure as we'll explore later. There are cases, however, where ground loss takes a back seat to coil losses. This is true of spirally wound and short stubby antennas particularly on the lower bands.

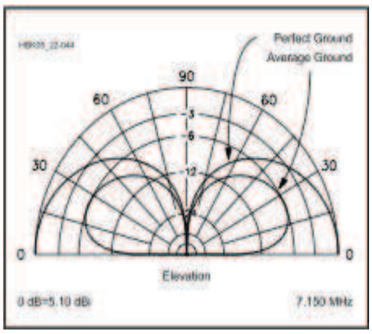
In fourth place are shunt capacitive losses in the mounting position and methodology, and are in parallel with the input impedance. They're typically small, but may be large in some cases; trailer hitch mounting behind a van is a good example. We'll explore this later too.

Lastly, there are some conductor losses in the mast and whip, but for the most part these can be ignored. Just for the record; the differences between antennas made of aluminum and/or stainless steel, and ones made of silver-plated copper is all but moot. In any case, they're only a fraction of those listed above.

Speaking of coil forms, almost universally the coil form of most screwdriver type antennas is some sort of phenolic, although some use PVC, Nylon®, polycarbonate (Lexan®), and even Delron®. No matter the material, or the dielectric constant of the material used, it's still a long way from that of common air! In other words, anything you place within the field of the coil effects its Q. Admittedly, some materials have more effect than others, but no material (even air actually) is RF transparent. If there is a constant, it is this. The more material within the field of the coil, the more the Q will be reduced. This not only includes the coil form, but any surrounding material, conductive or not. In case you missed the point, the mast, whip, end caps, guy wires, body of the vehicle, proximity of the surface under the vehicle, mount, and a few others, all affect Q!

Coil Q is important because it directly relates to the efficiency of the antenna as a system. It's difficult to measure coil Q without sophisticated lab equipment, but you can use a few thumb rules as a relative measure. For example, long skinny coils have low Qs. Short fat ones typically have high Qs. The best ratio is about 1:1. In other words, as long as they are all the same diameter. However, there are other deciding factors. Coils with a large amount of inductance, like those used for 160 and 80 metres, need to have a lower ratio. In this case, about 3:1 (3 times longer than the diameter) seems to be optimum. What's more, the size of the wire, the spacing of the individual turns, and the dielectric constant of the coil form all have major effects on Q, and the coil's optimum L/D ratio.

Digressing for a moment; it's easy to look at a loading coil of some design, and say to yourself; *that would be easy to duplicate*, and you'd be right, to a point. One often missed attribute [if you could call it that] of mobile loading coils is their distributed capacitance. When the distributed capacitance is increased, the self resonant point of the coil decreases. As your operating frequency gets nearer the self resonant point, losses increase rather dramatically. While there is more going on than meets the eye, the effect reduces efficiency to a point the resistive losses can actually destroy the coil. I mention this to drive home the point; there is more to a loading coil than a chunk of wire wrapped around a coil form.



Keep in mind that the position of the coil in the antenna is important too. The higher up it is mounted, more inductance is required to resonant the antenna. This increases losses because the coil Q goes down (higher resistive component). Depending on the operating frequency, the ground losses involved, and whether or not a cap hat is used, the most advantageous position maybe anywhere from the base to nearly the top of the antenna. The

It should be noted at this point, that ground losses effect the radiation at low angles, as illustrated in the chart at left. As ground losses increase, the mean takeoff angle (the angle of maximum radiation, ≈27°) changes very little. However, the amount of power radiated at any given angle does change, especially at the lower angles (<15°). Thus, we have yet another reason to minimize ground losses, by placing as much metal mass under the antenna as possible.

reasons for this are beyond the scope of this article. In general terms, the middle of the antenna is the best overall position. There is more on coil Q below.

Calculating Efficiency

Most amateurs know HF mobile antennas are inefficient when compared to a beam or simple dipole, but how much worse is a misunderstood concept? The simple reason is, efficiency is relative. It requires a defined baseline and without one it is just another word. The fact that you worked a few DX stations notwithstanding!

Before we set a baseline for efficiency, we need to know a little more about HF mobile antennas. The majority of HF mobile antennas are electrically short. For example, an 80 meter, unloaded mobile antenna 8 feet long is electrically 11° in length as opposed to 90° of a full-sized 1/4 wave vertical.

The overall length of an HF vertical antenna is just one factor in determining the radiation resistance. It is actually determined by the degree-amperes flowing in the radiating element. As mentioned above, .5 ohms is about right for a run-of-the-mill, 80 meter HF mobile antenna. For those wanting more information on how to calculate radiation resistance, the ARRL Handbook is the best place to start.

The input resistive component is about 0.5 ohms, and its capacitive component is about 1,800 ohms (.5r-j1800). In order to cancel the capacitive reactance, a loading coil is inserted in the antenna to bring it into resonance. Depending on the requisite loading coil's position (bottom loaded or center loaded) the coil's Q factor, ground and shunt losses, and resistive losses, the input impedance is closer to 25 ohms.

Ground loss, coil position, coil Q, mast size, whip size, and a few dozen other factors all play a part in determining the *input* impedance. While the radiation resistance doesn't change much between antennas of the same length, the unmatched input impedance does. In fact, it may be as low as 15 ohms for a really good 75 meter antenna installation, to as high as 60 ohms for a really lossy one.

The formula is: Rt=Rr+Rc+Rg, where Rt=total or input impedance, Rr the Radiation resistance, Rc the coil resistance (at the operating frequency, not DC resistance), and Rg the ground loss resistance. There are some other losses too. Shunt capacitance losses, conductor losses, matching losses, and even losses caused by our mounting method. For the most part we can ignore these as they’re small (usually, but not always) compared to the other losses were talking about.

We have some control over the radiation resistance, but for our 75 meter example above, the Rr is .5 ohms! Since it is *partially* a factor of the electrical length of the antenna we must lengthen the antenna to increase it. Doubling the length raises the radiation resistance by a factor of four. Obviously there is a limit to how long it can be, with 11 to 14 feet about the maximum (suburban, versus rural). If you live east of the Appalachians, perhaps just 8 feet (all assuming bumper mounting).

We can use cap hats to raise the Rr, but there is more to cap hats than meets the eye. Aside from adding complexity and wind loading, they have to be designed correctly, and *not* be in close proximity to the coil. Correctly implemented, it is possible to raise the radiation resistance by a factor of 4, on the lower bands. If they're incorrectly implemented, they will have the opposite effect.

The photo at right depicts an *incorrectly installed* cap hat. A cap hat installed this way will indeed increase the input impedance. However, the increase is due to increased coil losses, and not by an increase in radiation resistance. This incorrect mounting location also increases the antenna's bandwidth, but for all the wrong reasons.

The Rc is the resistive loss component of our loading coil which cancels the high capacitive reactance of our short vertical as measured at the operating frequency. This is not the same as its DC resistance. On 80 metres, the typical antenna loading coil will have between 75 to 200 µH of inductance depending on where in the antenna it is located. The higher up the mast, the higher the radiation resistance will be (to a point, and only to that portion of the antenna above the coil), but the larger the coil (more inductance) needs to be. There is a trade off limit, however, because the larger the inductance, the greater the resistive losses in the coil. The reactive resistance versus the resistive losses (at the operating frequency) determines the Q factor. The higher the Q factor, the less loss, and the more efficient the antenna will be. In a mobile environment it is difficult to obtain Qs much over 300 and even this requires good construction practices (I revisit Q factors later on in this article).

By far the greatest loss is Rg or ground loss. It typically varies between 5 and 20 ohms (10 through 160 metres), but can be much higher. It's dependent on frequency, the size and type of the vehicle our antenna is mounted on, and how and where the antenna is mounted. The left photo depicts a very poor installation, and one with an excessive amount of ground loss.

Keep in mind, any vehicle (even a semi) is an inadequate ground plane at HF frequencies. Since the body of the vehicle capacitively couples to the surface under it, Rg losses can be minimized by proper bonding of all bolted-on parts including doors, hoods, trunks, tail and exhaust pipes, bumpers, etc. Mounting the antenna as high as possible on the vehicle also helps as this reduces the coupling between the antenna and the surface under the vehicle. After all, we want the vehicle coupled to surface, not the antenna.

The coupling I'm referring to is more correctly called shunt capacitance. These shunt capacitances include, but are not limited to, the capacitance in the mount (2 to 4 pF for the average ball mount), that's caused by the close proximity of the mast to surrounding metal (difficult to measure, but could be as much as the antenna itself; 20 to 45 pF effectively shunting a large portion of the input power to ground). That's usually caused by the coil being too close to metal (again, difficult to measure, but this type of coupling has the greatest effect on efficiency and bandwidth).

Efficiency can be calculated (not exactly, but close enough) if all we know is the Rr, Rc, and Rg values. All we have to do is add these factors together to get Rt, and divide Rr by Rt. For an average 8 foot antenna mounted on an average vehicle, and using an estimated ground plane loss, the efficiency ranges between .2% on 80 metres to maybe 80% on 10 metres. These figures are based on data taken from the ARRL Antenna Handbook.

It should be noted that the so-called ground loss figures used by the ARRL (approximately 10 ohms on 80 metres to about 2 ohm on 10 metres which relates to about .004 µF of coupling) are low because shunt losses are not included, but they should be. Remember, a mobile antenna and the vehicle it is mounted on should be viewed as a system! As a result, 20 ohms to about 5 ohms respectfully is more realistic for the average installation, and perhaps a lot more depending on the antenna mounting location and mounting style.

While coil and other resistive losses are important, ground plane loss has the largest effect on efficiency. As the frequency goes down the losses go up. Remember, we are coupled to the surface, and capacitive

reactance goes up as the frequency goes down. This is why it is so important to minimize ground plane losses with proper bonding. It's also why radiation resistance becomes paramount especially on the lower bands. It further explains the popularity of cap hats on 160 and 80 metres where ground loss is highest and radiation resistance is lowest.

There is one more, important item to mention here. When ground losses increase, the likely hood of common mode currents flowing of the control wires (if any) and coax cable also increases. This is a critical point if you're using, or planning to use, a computerized Antenna Controller.

How Important Is Q?

Coil Q is a (*the*) hidden factor for most amateurs, so little thought is put into selecting an antenna with a high Q coil. As stated above, most commercial antenna coils have rather low Q. One of the most popular screwdriver antennas has an average Q of less than 50! Some better designed antenna coils approach an average Q of 300. Going higher than this is rather difficult, and doubling it (contrary to popular belief) is impossible! Based on these extremes (50 to 300), let’s look at two, otherwise identical antennas, with the only change being coil Q.

The numbers (factors) are taken right out of the ARRL Antenna handbook, so there cannot be any assumed improprieties from this writer. The antennas in question are eight feet long (about average for commercial HF antennas these days), center loaded, and using unmatched input impedances which include an estimated ground loss.

80 Metres: Q50 = 72 ohms coil loss. Radiation resistance = .8 ohms. Total input impedance = 84 ohms. Calculated efficiency = .9%

80 Metres: Q300 = 12 ohms of coil loss. Radiation resistance = .8 ohms. Total input impedance = 22 ohms. Calculated efficiency = 3.6%

20 Metres: Q50 = 15 ohms of coil loss. Radiation resistance = 11 ohms. Total input impedance = 31.5 ohms. Calculated efficiency = 34.9%

20 Metres: Q300 = 2.5 ohms of coil loss. Radiation resistance = 11 ohms. Total input impedance = 19 ohms. Calculated efficiency = 57.9%

In the case of our 80 meter model, that's an increase of 400%! The 2o meter model represents a 60% increase. Now ask yourself this; Is antenna coil Q important?

You just can't look at a coil and determine its Q. Nonetheless, there are a few things to look for. Diameters less than 2 inches, wound with wire smaller than size 14, or spaced closer than one wire width, are all parameters which place you closer to a Q of 50.

Bandwidth Notes

There is another Q factor we have to contend with, and that is the Q of the antenna as a system. The Q of a short HF mobile antenna is directly related to the coil's Q, the coil's distributed capacitance, the capacitance of that part of the antenna above the coil, any capacitance shunting the coil, where in the antenna the coil is located (base?, center?), shunt capacitive losses, the overall (effective) length of the antenna, the ground

losses, and the other resistive losses including radiation resistance. You might notice these are the same losses we deal with in maximizing efficiency. In short, while we strive to increase efficiency, we also increase the antenna system's Q which tends to reduce the effective bandwidth of the antenna. In other words, to increase efficiency we have to lower the resistive losses, or increase radiation resistance, or both. You can do both to a point, but there are diminishing returns with respect to cost, complexity, and of course physical size.

While it's common to relate (usable) bandwidth to the points above and below resonance where the SWR reaches 2:1, it isn't definitive. The reason is, you can have a wide bandwidth antenna that is very efficient. You can also have a very narrow banded one that's inefficient. So, why is bandwidth important? It really isn't much of a concern on 20 metres or above, but below 20 metres it is. Put another way, the bandwidth of an 20 meter antenna of reasonable quality will be about 150 kHz. The bandwidth of a similar quality antenna on 80 metres may be just 10 to 15 kHz.

Bandwidth is also dependent on the amount of capacitance located above the loading coil. All else being equal, an antenna with a large (properly mounted) cap hat will have a wider bandwidth, and higher efficiency, than one without. This is opposed to the common view about bandwidth.

Some amateurs incorrectly assume that inexpensive, low Q antennas are superior to some higher priced ones. The false assumption is, they don't have to retune their antenna as often so it's got to be better. Adding insult, a few misguided manufacturers tout their products extended bandwidths as an advantage. Both of these premises are false.

Besides using a tuner, another way to extend the bandwidth is to use a shorted coax stub across the antenna terminals. Selecting the correct length will not only match the antenna's input impedance to the feed line, its reactance is exactly opposite the antenna's reactance with any given change in frequency. Thus the 2:1 bandwidth increases (typically 30% to 50%). While the trick works well for a single band antenna (a different stub is required for each band), it's not a good solution for a remotely tuned antenna.

How Do You Know?

There is no easy, cut and dried, measure of antenna efficiency. Bandwidth, number of DX contacts worked, coil type, antenna type, mounting type, antenna shootouts, make, brand, matching method, cap hat or not, nil, not, nix, nothing! Even modeling can give you a false impression. So, the question remains; how do you know if it is efficient? Here's one way to get close, but no cigar.

In the Technical Correspondence section of the September 2006 issue of QST (page 57), are a few paragraphs written by Dr. Jack Belrose, VE2CV. Jack explains how to use an antenna analyzer and EZNEC to calculate the efficiency of a mobile antenna. The basic premise is to compare the measured input impedance of your mobile antenna, compare it to the modeled impedance given by EZNEC, and then adjusting the coil Q (resistive loss) until the two impedances (measured and calculated) equal. Then reading the programs calculated radiation efficiency.

There are a couple of things to remember when using this method. First, the analyzer's frequency must be adjusted until the reactive component is zero (X=Ø), and *not* for the lowest SWR. Then, and only then, will the resistive value be correct (within tolerances). The measurement needs to be made without any matching devices attached. In other words, we need to know the actual input impedance, not a transformed one.

We could also adjust the ground losses and get about the same basic result we do with adjusting the coil Q. After all, ground loss is the other variable we don't know (actual radiation resistance is the other). Depending

on the program used (Nec 2, Nec 4, EZNEC Pro, etc.) the spread of calculated efficiencies may be as much as 10%. If you error, always choose the worst case scenario, as the best case is assuming facts no in evidence. Lastly, just because your efficiency is great on 20 metres, is no indication what it will be on some other band, higher or lower. In fact, the higher bands may have greater loss due to capacitive coupling.

Incidentally, Jack wrote an article for QST entitled *Short Antennas for Mobile Operation* (September 1953, Page 30). My introduction was via the 1960 issue of the ARRL Mobile Manual which contains a reprint of the article. I still use the manual for reference, as it is the basis for all later treatises on the subject. Incidentally, an updated version appears in the ARRL Antenna Compendium #4.

Odd & Ends

The motor leads of a remotely-tuned antenna must be adequately bypassed. As I point out in this article, Antenna Controllers, inadequate bypassing will affect the input impedance, and thus the antenna's efficiency. How much this effect on either parameter depends on several factors; As long as the choke's impedance is at least two magnitudes larger than the antenna's input impedance, (> 5 k ohms), the effect will be insignificant.

There is a formula circulating the Internet which states that antenna Q is equal to 360 times the frequency in MHz, divided by the 2:1 VSWR bandwidth in kHz. One has to assume they mean antenna *system* Q, but that's not a given. While this formula *might* give you a comparison between antenna *A* and antenna *B* (all else being equal), the actual Q of the antenna (system or otherwise) requires a textbook-full of formulas, and a lot more information than just the 2:1 bandwidth! Fact is, this formula is no more specific than the number of DX contacts a specific antenna garnered.

Let's address short tapping once more. One of the basic design premises for all screwdriver antennas, is the fact the coil is not short tapped. Short tapping refers to shorting out some of the coil's turns to resonant the antenna. Contrary to popular opinion, this has very little effect on coil Q until a large portion (>70%) of the coil is shorted out. Even then the effect is minimal, and measuring the difference requires good laboratory equipment.